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Extreme weather events in West Hungary

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Summary: Agricultural production is a rather risky activity, as it is largely exposed to extreme weather events. This paper focuses on the frost and hail data in springtime, affecting fruit production in West Hungary. Regarding absolute minimum temperatures in April, significant increase of the standard deviations could be observed. Among the sites examined Nagykanizsa shows the highest risk values. According to our evaluation Nagykanizsa is not recommended to plant sour cherry, sweet cherry and apricot orchards because in some years spring frost will occur. If the plantation is in Zalaegerszeg, Szombathely, Győr or Keszthely than usage of frost prevention system is recommended. Siófok is the only area to grow apricot with good result.

Key words: hail, spring frost, apricot, sweet cherry, sour cherry

Introduction

Agricultural production is a rather risky activity, as it is largely exposed to extreme weather events. Based on the surveys of the Ministry of Agriculture and Rural Development and of the Association of Hungarian Insurance Companies *Sütő* (2009) indicated the occurrence of drought damage as the most significant (39,1%), followed by hail damage (22,3%), inland waters (21,1%) and frost damage (14,8%). The climatic indicators can be easily related to risks and may serve also the analysis of effects of climate change (*Ladányi et al., 2010; Persely et al., 2010*).

Nowadays the corner stone of modern fruit production is efficiency which practically means first class fruit quality, high and safety yield, even if unusual weather conditions occur. Therefore the winter and spring frost hardiness of the different varieties is important. This paper focuses on sweet cherry, sour cherry, and apricot varieties. The critical period for these fruits is from the end of internal dormancy to the end of flowering. Winter frost hardiness of sour cherry, sweet cherry is good enough during dormancy period of the common varieties in Hungary. On the other hand some apricot varieties with short internal dormancy phase possibly have winter frost damage in cold years (*Crabble, 1994; Szalay, 2001*). The research focuses only on flower buds as the other parts of the tree are more frost hardy. There are two important factors of spring frost: the number of frosty days during flowering and the minimum temperature occurred. The production areas can be assessed for production safety according to these two factors.

Sour cherry is the most frost resistant fruit out of the three species. It can stand –25°C during winter dormancy. The flowering period depends on the spring temperatures but generally occurs between 20th March and 30th April. Varieties have different spring frost resistance. While flowering stage is going on the level of resistance is reducing until –2°C, the critical temperature during flowering. Flowers are possibly freezing if colder weather occurs.

Sweet cherry is less resistant than sour cherry but more than apricot. It can stand the same minimum temperatures during dormancy like sour cherry. Critical period is during flowering 3rd decade of March – 3rd decade of April. Critical temperature in flowering is –1,5°C.

Apricot is the most sensitive and there is a big deviation among the different varieties. Resistant varieties like 'Rózsa kajszi C 1406' can stand the same winter and spring frost temperatures as sour cherry but a sensitive variety for example 'Roxana' is much less resistant than sweet cherry. Therefore in case of apricot production the assessment of the different areas is essential. In some areas of Hungary it is not recommended to grow apricot because frost – mainly spring frost – can damage 60–100% of the crop. Blooming period is about 3 weeks before cherries 20th February – 30th March. Temperature –1,5°C is the critical level but as the blooming is earlier, spring frost damage has a higher probability.

Materials and methods

Meteorological data were recorded by the Hungarian Meteorological Service (HMS). The available data set covers basically the time interval 1951–2009, but unfortunately there are missing values. Therefore in case of minimum temperatures the period 1964–2009 was analysed.

We must face to the problem that some parameters – like type of the precipitation – are not recorded at all meteorological stations. The knowledge of duration and intensity of the daily precipitation would be also very useful.

In case of comparing values of two periods the Analysis ToolPak of the Excel 2003 was used: comparison of the

variances with F-test and then comparison of the means by t-test in case of equal variances or t-test in case of unequal variances (Welch-test).

Results

Absolute minimum temperatures in April

The absolute minimum temperatures in April were analysed, as it is the main blooming period of many fruit species. There is no trend in the whole data series, but the second part of it shows more variability (*Figure 1.*).

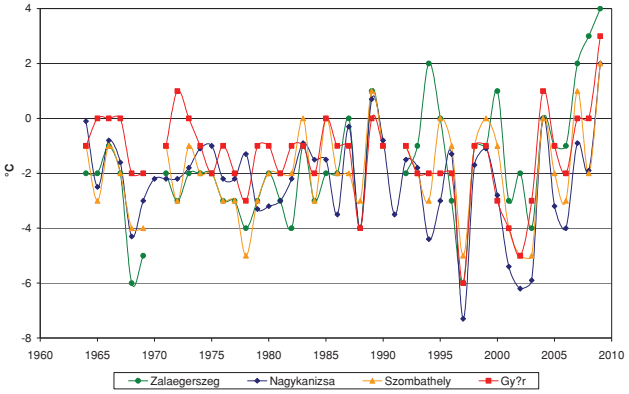

Figure 1. Absolute minimum temperatures in April

Therefore two periods were defined (1964–1985 and 1986–2009) and statistical analyses were done to compare the means and standard deviations (*Table 1*). The means of the absolute minimum temperatures did not show significant differences except in Zalaegerszeg. In case of the standard deviations statistical analyses proved the increase of them.

According to the results is clearly visible that the area of Győr is good for sour cherry and sweet cherry production in the aspect of minimum temperatures. There can be more problem with spring frost in the areas of Szombathely and Nagykanizsa as the minimum temperatures are below –2°C and standard deviation is higher.

Table 1. Absolute minimum temperatures in April – summary of statistics

	Mean			Standard deviation		
	1964–1985	**1986–2009**	**sign.**	**1964–1985**	**1986–2009**	**sign.**
Zalaegerszeg	–2.71	–0.83	**	1.23	2.37	**
Nagykanizsa	–2.00	–2.57		0.98	2.28	**
Szombathely	–2.24	–1.69		1.30	1.94	*
Győr	–1.05	–1.65		0.97	1.97	**

Significant differences: * p<0.05, ** p<0.01

The most risky is Zalaegerszeg because means of minimum temperatures are –2,71°C and –0,83°C in the two periods examined. The second period is relatively good for sweet and sour cherry but the standard deviation is 2,37°C, the biggest across all areas which means that Zalaegerszeg has the most extreme temperature range. Frost prevention system is recommended to avoid damage in this area. In case of apricot all areas are risky. These are not the main areas of apricot production in Hungary and our findings shows one of the causes. A surprising result is Győr because it is a plain area and spring frost damage usually occurs with higher probability in such places. Apricot is better grown close to mountains of North-East Hungary and around Lake Balaton. In West Hungary the biggest production area are Tolna and Fejér counties. Taking into account the minimum temperatures sweet cherry and sour cherry are recommended to grow in Nagykanizsa, Győr and also in Szombathely area with some frost prevention methods.

Number of frosty days in April

In the period examined there is no trend in the number of frosty days in April and no statistical difference can be found between the formerly analysed two periods. Comparing the sites the number of frosty days was significantly the highest in Nagykanizsa (*Figure 2*).

The volume of the future yield depends not only on the frequency, but also on the temperature of the frosty days. The peak can be found in 1997, in this year in Nagykanizsa and Keszthely temperatures below –6°C were recorded, too.

In 2002 February and March were warmer than usually therefore the cool and frosty days in middle of April caused serious damages in blooming fruit plantations. Especially in Nagykanizsa, where the temperature dropped below –6°C again.

The year 2003 had many extreme temperature values. The monthly averages from January to April were below the long-term means – so the number of frosty days is also high – but the summer was extreme warm.

In the year 2007 several orchards were suffered spring frost damages in almost the whole country. It was very critical in East Hungary, where the frost damage caused entirely crop failure (*Nagy* et al., *2008*), but orchards in the West Hungary did not have serious damages (*Szabó* et al., *2008*). As it can be seen in *Figure 2*, only in Nagykanizsa were frosty days in this year.

Generally speaking about the examined production areas Siófok and Győr are the least risky, there were the number of frosty days during April the lowest in the last 45 years. Siófok has outstanding results so it is recommended for apricot production as well.

One of the most extreme years was 1997 but even in this year in Siófok the cold was moderate and there were only two frosty days. In the monitored time interval Győr and Keszthely are similar, however Győr has slightly more years with frosty days, but the extent of the frost was greater in Keszthely. All in all for apricot production only Siófok is recommended out of the measured places.

Sweet cherry is more spring frost resistant so Győr, Zalaegerszeg and Szombathely are good growing places for that. *Figure 2*. shows that in some years –6 – –4°C occur so frost prevention is a basic question there. Irrigation or other techniques can be used for that which can protect flowers

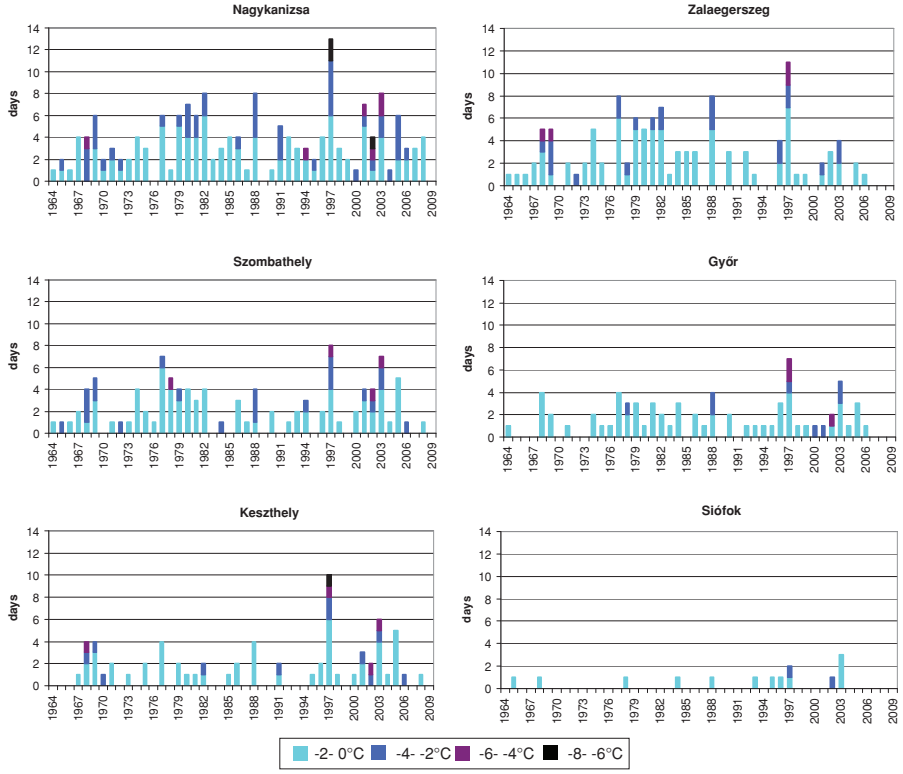

Figure 2. Number of frosty days in April

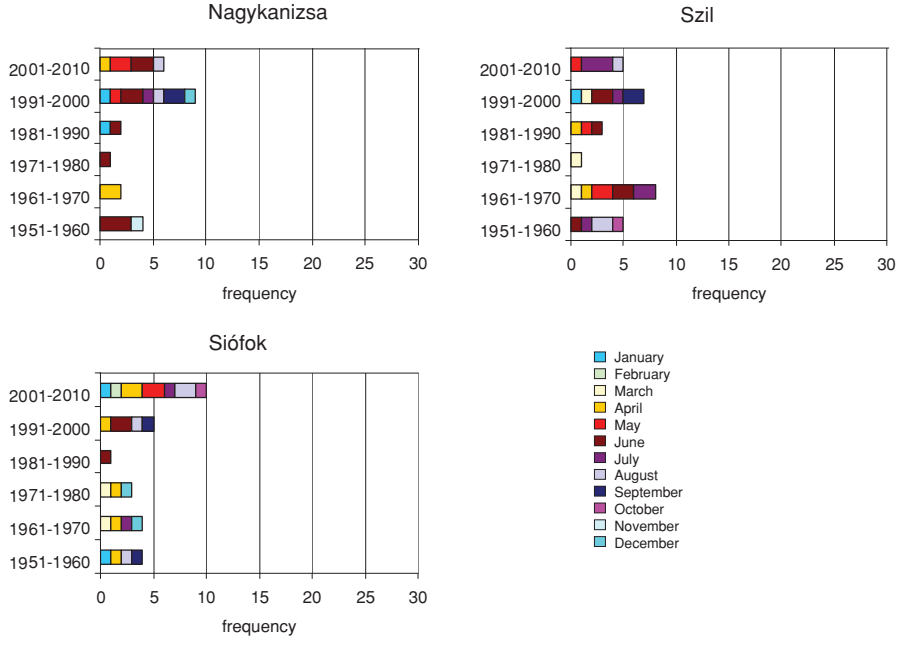

Figure 3. Frequencies of hail events (1951–2009)

even at -6°C making the production profitable even in the extreme cold years. Nagykanizsa is the worst in the aspect of spring frost because in some years temperatures colder than –6°C occur. Even with frost prevention such cold temperatures possibly cause significant frost damage on sweet and even sour cherry flowers.

According to our evaluation Nagykanizsa is not recommended to plant sour, sweet cherry and apricot orchards because in some years spring frost will occur. If the plantation is in Zalaegerszeg, Szombathely, Győr or Keszthely than usage of frost prevention system is recommended. Siófok is the only area to grow apricot with good result.

Hail event frequencies

Hail events are not rare in Hungary. Disregarding the spatial and temporal differences, there are about 70–140 days in Hungary with hail events. *Szuróczki & Tőkei (1985)* estimates the yearly number of hail days at a certain place between 1 and 3. In the three West Hungarian meteorological stations – from where we have data – the ten-years frequencies are below 10, but in Nagykanizsa and Siófok the number of it was slightly increasing in the last decades (*Figure 3*).

Based on the literature the most dangerous months are May, June and July (*Bálint, 1967; Wirth* et al., *1985).* Data from Nagykanizsa and Szil show similar distribution, but in Siófok hail events in April were more frequent.

Hailstorm is a problem for all fruit species grown in Hungary, but protective systems are still rarely used in orchards. On of the reasons is the high construction costs, but another reason is the cultivation system of the plantations (*Soltész* et al., *2006*). Generally in old orchards (10–20 years of age) there is big spacing (7*5 m; 6*4 m; etc.) and the canopy height is higher than 2.5–3 meters. Therefore the hail protective net can be placed hardly above the trees and in big spacing the unit cost is much higher than in case of a modern orchard with for example 4*2 m spacing and approx. 2 m canopy height. Hail has different effects on the fruits in different phonological phases. During March and April a hailstorm can knock down the flowers from the trees. There is no foliage on the tree so the hail makes damage directly on the flowers or young fruits. One month prior the harvest period the hail mainly cause damage on the surface of the fruit (brown scab). 10–15 days before and during the whole harvest period a hail event can damage the flesh of the fruits (brown areas inside) and even can break the peel. If the fruit peel has broken mildew and other fungi are possibly occur so the product can not be sold for fresh market or for industry.

Apricot varieties without red cover colour are more sensitive because even 1–2 mm diameter brown scabs are visible. In case of European first class apricot no peel errors are permitted. Red sweet cherry varieties are less sensitive, because the hail damage (brown area under the skin) is less visible than in case of yellow cherries. Sweet and sour cherry only with error free peel and flesh can be sold on fresh market. Brown spots on the cherry fruits are not permitted for canning industry these fruits can be sold only for juice factories.

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